NOTES

1. Papers selected for inclusion in General Sessions will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

2. Papers selected for inclusion in Specialized Sessions will be available at the Conference in only one of the above official languages.

3. Summaries of all papers, as submitted by contributors, will be available at the Conference in the following official languages of the United Nations: English, French, Russian and Spanish.

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AN APPROACH TO A MINERAL RESOURCES DEVELOPMENT POLICY IN DEVELOPING COUNTRIES

by

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INTRODUCTION

1. Among the various categories of natural resources, minerals are distinguished by four physical and two economic characteristics.

2. The outstanding physical characteristics are that: (a) minerals are non-reproducible and, consequently, mineral deposits can be physically depleted;1/ (b) minerals are non-perishable; the economic implication being that mining operations can be flexible since the minerals can be left underground whenever demand slackens; (c) minerals are difficult to discover, though the difficulties in finding them vary greatly according to the type of mineral sought and the area under exploration. Consequently, exploration is, usually, the most risky part of mineral development; (d) there are many known minerals, currently about 1200, and the list increases every year. While the majority are not of any economic significance now, and some probably never will be, rapidly advancing technology creates new needs elevating neglected minerals to a position of prominence.

3. The two outstanding economic features are:

A. A mineral deposit is a capital asset

4. Once an economic mineral deposit has been found, it represents a capital asset - an addition to the known wealth of the country. Correspondingly, the physical depletion of a mineral deposit decreases the known wealth of the country. Statistics of national income and capital formation neither count a discovery of a mineral as capital formation nor is depletion taken into account in computing disposable national income.2/ Therefore, national income and similar economic data do not adequately measure the significance of the mining industry. Similarly, and this is significant for those less-developed countries largely dependent on petroleum

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1/ In a country as a whole and also within one deposit or mine, minerals may also be depleted in the sense of rising cost of recovery, meaning that rising costs due to deeper mining, reduction in ore content, etc., may make the remaining ores uneconomic at least for some time.

2/ See Joseph Barnea, "National Income, Capital Formation and Natural Resources", Kyklos, 1956, No. 3.

and other mineral exports, national income data, as they make no provision for depletion, may hide a real consumption of wealth. In all old mining areas, in developed as well as under-developed countries, there are abandoned mines and often also ghost towns, once flourishing, but now deserted because the deposits on which they were based have been worked out.

5. Furthermore, the economic significance of mining cannot be satisfactorily measured by the employment it provides, because labour intensitiveness varies among minerals; it is very low, for instance, in petroleum and natural gas production but much higher in metal mining. The economic significance of mineral production depends not only on the mineral, but also on its location and the structure of the economy of the country in which the mineral deposit is found. Generalizing, one can classify the economic significance of mining in less-developed countries, as follows:

(a) earner of foreign exchange;1/

(b) raw material for manufacturing industry, building and construction industry, industrial diamonds and other minerals for cutting, etc., fuels and natural steam for energy production, underground water for many purposes, salt and other products for food and basic chemicals, radioactive minerals for various purposes, mineral springs and many minerals for medical purposes and medicines, diamonds and other precious or semi-precious stones for jewellery and finally, gold, still the primary financial asset, the basis and backbone of all strong currencies;

(c) mineral exploration and investment often is the pioneer and vehicle of development of neglected, uninhabited or inaccessible areas. Frequently it is the exploitation of minerals alone that provides the economic basis for the construction of roads or railways. In desert areas, for example, while many oases are to-day decaying because the slow camel transportation is being replaced by trucks, other new settlements are being established for the exploitation of minerals. Mineral development is, therefore, frequently the catalyst, as well as the basis for new development.

B. Mining is capital intensive

6. Mining, in general, is capital-intensive, though there are considerable differences according to (a) the type of mineral; (b) the type of mining, (c) need and type of processing and (d) need and type of transport facilities. Annex I shows for a few categories of minerals, the differences in investments among the various stages. As will be seen later, the relationship between the various stages has a decisive bearing on the economics of mineral development in developing countries.

1/ It is of interest to note that minerals have played a leading role in foreign trade since the early days of international commerce. Moreover, the now industrialized countries used to be important exporters of minerals and even today, petroleum is the main export commodity of the Soviet Union and the U.S.A. is a substantial exporter of coal, sulphur, phosphates, molybdenum and potash.

CHAPTER I

THE PRE-CONDITIONS FOR MINERAL DEVELOPMENT

A Proper Mining Law

7. Without a mining law, no mining rights can be established and few private investments in mineral exploration or development can take place. A bad mining law is, however, worse than no mining law because it may establish rights without any corresponding duty to explore and develop minerals, while, at the same time, such rights may prevent others from doing so. Too many less-developed countries still have inadequate and outmoded mining laws such as the old Spanish law in many Latin American countries, Islamic laws in some Moslem countries, etc. A modern mining law is a pre-condition for a healthy mineral development.

Basic Geological Information

8. Mineral development on a rational basis cannot be carried out in the complete absence of geological information. Though the degree of detailed geological information required at a certain stage depends primarily on economic factors there is a certain amount of basic geological information which is important and which is needed at the outset before any money is spent on exploration. The costly time-consuming and old-fashioned methods of geological mapping carried out by sturdy geologists exploring the terrain on foot can now be replaced by photogeology in most cases. Photogeology is based on the proper interpretation of aerial photography, a practice which is now quite common and which should be carried out in all developing countries because such photographs have multi-purpose uses. Photomosaics and photo-geological maps will generally provide sufficient general geological information to permit selection of areas with the highest potential for economic discoveries. The proper safeguarding of photogeological maps together with other relevant information such as geological reports, samples of minerals collected, data obtained through core drilling, etc., should be concentrated in one national bureau so as to have somewhere a central inventory of the country's knowledge of geology and minerals. Unfortunately, there are still countries in which such a central inventory does not exist. A repository of basic geological and mineral information of this type will normally be located in a geological or mineral department of the Government. The minimum tasks and the minimum size of such a Government Department will be discussed in the following section.

An appropriate government service

9. A government geological and mining service is an institutional requirement for any independent country, large or small, whether it is already a "mining" country or not. The size of the service will naturally depend on the size of the mining industry and the size of the country. However, even the smallest country cannot afford not to have a small office in which the government can centralize the geological and mining information which is available and through which the government may keep itself informed on national developments in this field. If such an office does not exist then it is probable that geological, hydrological and mineral exploration data acquired by private companies or even by government development companies is not safeguarded and consequently valuable knowledge may be lost. Moreover, as governments have to take an increasingly active part in providing the framework of knowledge on which investments and similar decisions concerning mineral development can be based, a government geological and mineral service will gradually have to assume greater tasks and wider functions.

10. In some of the industrial countries, a sharp distinction is made between geological institutes and mining departments. Experience has shown that in developing

countries, it is unnecessary to have such separation and that a combined geological and mining service can avoid inter-service rivalries and minimize government expenditure. However, as soon as a government decides to undertake the development and operation of mines it is advisable to view this function not as a Government service but as a business operation which should be managed by an autonomous public mining corporation or government development agency.

11. Experience has shown that wherever there is no government geological survey or mining department, the government cannot be active in the field and in these cases one frequently finds that the growth of a mining industry is considerably retarded.1/

The need for a long-term mining policy

12. The acquisition of geological knowledge and the development of mining is a long-term process which can easily be disturbed by frequent changes in government mineral policy. For example, a government may decide to finance the development of a mine but, in so doing, it must be able not only to underwrite the necessary expenditure for one year but to make provision for the financing of such programmes over a considerable number of years. The opening of an underground mine which has to stop because of shortage of money during development may not only endanger mine workings but may also, through postponement of production, lead to substantially increased costs. Similarly, an exploration programme interrupted in the middle may fail to produce any conclusive information on which further action may be based and therefore, the funds invested may remain unproductive.

13. In those cases where a government has decided to leave some or all exploration and development of minerals in private hands, such a decision will only lead to investment if a "climate" exists in which the policy decision by the government is regarded as a long-term policy not subject to frequent changes. Experience has shown that a long-term mining policy is of crucial importance for development of a mining industry in less-developed countries.

14. This statement should not be interpreted as meaning that a decision to allow private capital to explore for and develop minerals on the basis of a modern mining law, will be sufficient to bring about large-scale investment in exploration and development, because actual investments will also depend on a number of related and inter-locking questions such as the prospects for finding economic mineral deposits, locational aspects, potential markets and other questions. In some circumstances, in addition to a long-term mineral policy, the government may have to take certain other steps designed to provide inducement and incentive. What is certain, however, is that without an established and clearly understood mineral policy, even the additional steps and measures taken by the Government are not likely to produce significant results on a long-term basis.

1/ En passant, it may be mentioned that the Special Fund will not accept a project for mineral exploration unless the country possesses a geological or mining service, even a small one, capable of continuing the work begun with United Nations funds.

CHAPTER II

ELEMENTS FOR A SUSTAINED MINERAL DEVELOPMENT POLICY

The variety of conditions in mineral investments

15. In the Introduction, attention was drawn to the 4-stage character of practically all mineral developments, namely, exploration, extraction, processing and transportation.1/

16. Each stage has its own problems with attendant investment requirements and the variations between these requirements are of great importance for developing countries, but of far less importance for industrialized countries with well developed infrastructures. The table in Annex I shows, for instance, that for gold and diamonds, exploration costs are either low or medium high and extraction costs might be either low, medium or high. But processing and transportation costs are relatively minor or even negligible. Consequently, these are the minerals for which to explore in landlocked countries with no transport facilities. Countries such as Chad, Niger, Upper Volta, Afghanistan and others far from the coast and with limited transport facilities, could, at a relatively low cost, develop valuable export industries if they concentrated on such minerals, assuming their existence in economic quantities.

17. Industrial minerals such as potash and other salts may, if available in surface deposits, require only medium investments in practically all stages and may, therefore, be easier to finance in many developing countries than metallic minerals which call for high investments and costly processing facilities, unless unusual location advantages and high-grade deposits allow the export of direct shipping ore.

18. These few examples indicate that the variety of the investment requirements of minerals must be taken into account in studying the possibilities in a given country. This applies not only to mineral development but also to the planning and implementation of exploration programmes which should be designed to fit the total picture - geological, geographic and economic.

19. Most of the minerals processed for immediate local industries use such as clays, glass sands, gypsum, building stone, etc., have moderate exploration costs and low extraction costs if open-cast methods can be applied. In a mineral development programme therefore, such minerals should not be neglected if the establishment of local industries is also envisaged.

20. The table in Annex I indicating the various stages of mineral development is obviously insufficient, for a considerable number of minerals, when decisions on investments and processing facilities have to be made.2/ The processing of some minerals, such as bauxite and most other metallic minerals, is energy-intensive. Consequently, processing of such minerals should only be considered if low-cost energy resources are available. Conversely, if low-cost energy resources are available, this may constitute a strong reason for giving priority to exploration for those minerals which require energy-irtensive processing facilities.

21. These general recommendations will, for their practical application, have to be supported by far more detailed studies concerning the costs of producing and transporting minerals, existence of potential markets, etc. It cannot be overemphasized that such fact-finding analyses are an essential prerequisite to any investment programme.

1/ In some cases, minerals are simply extracted and used locally, thus avoiding processing and transportation.

2/ The availability of labour, capital and other factors of production are assumed here.

Investment in knowledge

(a) Geological knowledge:

22. It has been pointed out earlier that the availability of geological information is a pre-condition for almost all mineral development. All mineral exploration involves an element of risk, but this risk can be substantially reduced in many cases by the early availability of sufficient geological and geophysical information. Governments in developing countries, therefore, have to assume greater responsibilities in providing the infrastructure of geological knowledge necessary before any detailed exploration programmes are undertaken. Nowadays, the infrastructure of information can be obtained in a relatively short time through photogeology and airborne geophysical surveys. By providing geological maps based on photogeology and geophysical data based on airborne geophysical surveys substantial information will become available for the preparation of an exploration programme. In countries where private interests, local or foreign, are allowed to explore for minerals, the availability of such information will act as a stimulant for investments in exploration. There is no hard and fast line between the collection of basic geological information and exploration. Thus in certain countries, and in certain circumstances, wherever the infrastructure of information provides strong indications of the availability of minerals of considerable economic significance, a government may decide, in the absence of private capital, to commence exploration activities by investing funds in the first stages of exploration through pitting, trenching and test drilling.

23. While developing the infrastructure of knowledge, namely geological mapping and other relevant information, is quite expensive, it is nevertheless now accepted as a task of governments. For this reason, the Special Fund is willing to participate in the cost of mineral surveys, and has already done so in about 30 countries.

24. In programming the geological infrastructure it is obviously impossible, in most countries, to cover the whole country. Therefore, preference should be given to areas which show indication of mineralisation and which either possess certain transport facilities already or are so located that these could be provided with relatively small investments. Correspondingly, areas which are inaccessible and for which government development programmes do not provide for the construction of transport facilities in the near future, should be the last areas for which the geological infrastructure is provided.

25. Expensive as this infrastructure of geological knowledge is for the budget of developing countries, the sums involved are small compared to the capital requirements of detailed exploration programmes, at least insofar as fuel, metallic and some industrial minerals are concerned. For this reason, funds for an intensive exploration programme will need a much closer economic analysis and justification than the approval of funds for the infrastructure of geological knowledge.

(b) Laboratories:

26. An active geological programme requires laboratories for mineral testing and follow-up exploration, and mining activities require various other laboratories. At an early stage therefore, governments must be aware that the scientific infrastructure required for a mining country or for a country which hopes to develop a mineral industry, calls for the establishment of a series of laboratories for analyses and testing. Such laboratories, in order to serve not only government services but also large and small mining companies, prospectors, and operating mines, should preferably be government owned and attached either to mineral institutes or to a university. It is also essential that whenever laboratories of this kind are established, they should be staffed by competent experts with modern equipment, because a laboratory which cannot provide reliable testing is worse than no laboratory.

27. The timing and type of laboratories required in a country will depend on the stage of economic development of the country as well as on the geological and mineral conditions.

(c) Human skill:

28. It is not sufficient merely to provide for the teaching of geology, mining, analytical chemistry, ore dressing and associated sciences at local universities or abroad; what is more important, is to provide favourable conditions of employment and a professional climate which will allow trained people to remain up-to-date in their profession. This first requires a salary level which makes such professions attractive in order to prevent the best-trained people from turning to more lucrative pursuits or even leaving the country for better-paid jobs abroad. It is also necessary that experts have sufficient funds to subscribe to professional journals, to attend, from time to time, international conferences and to visit mines and institutes abroad. Such investment in human skill, though recognized by most people as essential, nevertheless runs into considerable difficulties as the payment of higher salaries to geologists, mining engineers, etc., tends to disturb the salary structures of government service. Experience has shown that this problem can be solved by the establishment of geological and mineral institutes which, though owned by the Government, are, nevertheless, separated from Government service and enjoy a special status including higher salary scales. If developing countries do not find ways of retaining their highly skilled local personnel with adequate salaries, they will have to employ foreign experts at much higher cost.

Government mining corporations or agencies

29. A number of developing countries have set up government agencies in order to operate mines and mineral processing plants. There is no general judgement one can render on such agencies. Indeed, in some situations, when private capital is not willing to develop these minerals, the government may have no choice but to invest its own funds if the development of such mines is regarded as a matter of priority by the government. It should be borne in mind, however, that if private capital is forthcoming for other investments (and the government is willing to allow private capital to invest in minerals) the reluctance of capital to develop such mines might be due to a difference in the economic evaluation of such mineral deposits. Nevertheless, there are a number of cases where, from the overall point of view of the necessity of economic development, the government may have no choice but to invest its own funds in order to develop certain mines. U.N. experience has shown that only in a relatively small number of cases have government-operated mines been worked successfully. It is essential, therefore, to know something about the basic reasons for failures in order to avoid common mistakes.

30. First of all, a government deciding on a mineral development must know that a mining operation is a commercial enterprise and cannot be carried out within the framework of a civil service and of a government budget. Such operation should, therefore, be carried out in a separate business organization owned by the government but not subject to civil service regulations. The mine manager must have full authority; otherwise he may have to ask the civil service for authority for each purchase of spare parts or for the employment of workers, for example, and the operation will surely be a failure. In addition to the separation of the mining operation from the work of geological and mineral services, it is also essential that the managerial positions be filled by competent people and not by politicians, that the mining management starts with sufficient funds and that it has full authority as regards all operations of the mine. There are government-owned and operated mines not only in the centrally planned economies but also in Western Europe and quite a number of them are successful business enterprises. However, if one analyses the reasons for the success of such mines, it becomes apparent that it is due to an efficient, competent and independent mine management, to a good mineral deposit and to isolation from political interference. Countries which do not

possess sufficient competent personnel to operate mines would therefore have to rely on foreign experts and, if this is undesirable, such countries should carefully review the situation before they decide on government management of mines.

Diversification

31. The development of a large mineral deposit for export is usually easier than the simultaneous development of different minerals for export as well as for local industrial and other use. A large deposit of an economic grade and/or one which is relatively well located, may justify the establishment of specific means of transport such as railways or pipelines, and the export may yield foreign exchange in a relatively short period. This type of development, in which international companies have had much experience, is usually of undoubted benefit to the country. However, in many cases, the economy of a country is developed around one single mineral product, and variations in price and other market conditions for this one mineral will have a widespread effect on the economy of the country as a whole. In this category one finds petroleum export countries, iron ore and copper export countries. It is obvious that a single-mineral economy is not a healthy long-term structure for any country. Nor is it in most cases a necessity created by nature. It has already been pointed out in the Introduction that there are very many minerals and therefore diversification in mineral exploration, development and production as a considered policy would often allow the avoidance of a single-mineral product development. Such a policy however, can only effectively be applied if the government provides the necessary geological infrastructure and other facilities, if necessary, for the exploration and development of other minerals. It is also imperative that possibilities of local utilization of minerals for industrial and other purposes are borne in mind from an early stage and that attempts in this direction are supported on a long-term basis. In practically every country, even the smallest ones, there are possibilities of developing several mineral-based industries such as glass-making, ceramics, cement and other building industries and some other industries including a few chemical industries. Countries which are today in the position of a single mineral production economy should pay special attention to this problem and accclerate their efforts towards diversification of their mining sector.

CHAPTER III

SOME SPECIFIC PROBLEMS IN DEVELOPING COUNTRIES

32. Small-scale mining

Small-scale mining still exists in a number of developing countries such as Chile, Burma, Pakistan, Philippines and Bolivia. In practically all cases, small-scale mining represents the backward, or even primitive, sector of the mining industry. Too often small mines are operated without any mechanical equipment, and without any technically competent advice on mine design, methods of production, etc.

33. As small mines can operate profitably if they are operated by professionally trained personnel and use up-to-date methods of production, there is no reason to assume that, under all circumstances, only large mines are the advisable economic form of mineral exploration in developing countries. In many cases, mineral deposits are small and large international mining companies are neither interested nor capable of operating such small mines on a profitable basis. Nor are government agencies, as a rule, in a position to manage small mines effectively. In such countries, therefore, where international companies and government agencies cannot operate small mines but where small mineral deposits exist, the government has the choice, either of disregarding small mineral deposits and, wherever primitive small-scale mining still exists, of allowing such mines to die out gradually; or it has the choice of assisting in the modernization and, if necessary, also in the financing of small mines by providing technical assistance in planning and operating the mines, in training personnel and, if necessary, also in financing the purchase of equipment and marketing of ores.

34. United Nations technical assistance provided in some cases to such mines has indicated that in a number of countries, small-scale mining, if properly modernized, can make a valuable contribution to the economic development of the country. In one country it was found that coal mining was carried out on a small scale because coal deposits were small and dispersed, although the coal itself was of a high quality; production was declining year by year and the industry was regarded as a dying one. A United Nations coal mining engineer sent to that country found that, with the introduction of new methods, coal mining costs could be lowered very considerably and output increased substantially. He also found that there was not a single experienced coal mining engineer in the country, and the complete lack of technical knowledge in the field was the decisive reason for the decline of this industry. Similar experiences have been encountered in other countries. In some cases, it was found that the mining law allowed the establishment of mines of such limited size that mines could not develop the long-term reserves required for rational planning and efficient methods of extraction. These and other weaknesses can be overcome and, in many cases, small-scale mines can make a valuable contribution to the mineral production of a country, often at low cost.

35. It is essential, therefore, that in any economic programming due attention be paid to the possibilities of small-scale mining and its appropriate place in future mineral production.

Rehabilitation of neglected mines

36. Connected with the question of small-scale mining, although not identical, is the question of the rehabilitation of closed or abandoned mines. In the past, almost all valuable minerals produced in developing countries were largely, if not exclusively, exported, and often only high grade ores were developed. When the high grade ores were mined out, mines were closed or abandoned. To some extent, this applies also to mines of earlier historical periods. Technology of extraction and

processing is a dynamic field in which advances and changes in technology are constantly taking place. Some mines closed down 50 to 60 years ago because the low grade reserves were at that time uneconomic may now be profitably worked due to technological improvements.

37. As a rule, it is less costly to rehabilitate neglected or abandoned mines than to explore for new mineral deposits, opening new mines, etc. It is true that the rehabilitation of neglected or abandoned mines may require a higher technological competence and may pose more complicated technical questions than exploration; nethertheless, it is advisable that government mining departments keep under periodic review the information which should be available in their files on abandoned and neglected mines. The rehabilitation of a mine can usually be effected in a short period of time, measured in many cases, in months rather than years. Therefore, vigilance should be exercised in order to take advantage of short term fluctuations in mineral prices.

38. Connected with the question of rehabilitation of abandoned and neglected mines is the timely study of the technology of treatment of lower grade ores before the higher grade ores are fully worked out. If this is done, the closing of mines can be prevented and the social and economic disturbances created by such closing be avoided. In one country where a large mine employing thousands of workers and representing an important earner of foreign exchange is approaching the exhaustion of its high grade ores, a U.N. expert has drawn the attention of the Government to this problem. The proving of sufficient tonnage of low grade ores plus the development of efficient treatment of the lower grade ores are now the subject of a Special Fund project. It is hoped that this project will not only lead to a very considerable extension of the life of this mine and to the expansion of its activities, but also that it will result in the establishment of a mineral processing plant in the country, which happens to possess cheap hydro-electric power.

39. In other cases, U.N. experts have studied abandoned mines and sometimes found that by application of modern technology, these mines can be rehabilitated. However, a word of caution is advisable here. Governments should not indiscriminately view all abandoned mines as potential assets. Some of the operators of yesteryear, e.g. the Spaniards in Colonial America, were amazingly efficient in maximizing recovery of even low-grade minerals.

Mining in Dry Areas

40. A considerable number of developing countries suffer from a shortage of water and a large percentage of the known mineral deposits are located in deserts or semi-arid areas. Thus, there are difficulties in obtaining sufficient quantities of water not only for mining operation but also for concentration as well as for the personnel and their families living nearby. In a number of cases, the lack of water has prevented the development of very interesting mineral deposits. In other instances, for example in some mining areas in the Middle East, water is rationed. What is needed, therefore, is the development of dry processes instead of wet concentration for mines in water-short areas. During the last few years, a sensational advance has been made in this direction and a considerable number of processes have been developed. Some of these show such general advantages that they are even introduced in areas where there is no water shortage, such as Canada. However, at the moment, it appears that the knowledge of this latest development has been little disseminated in developing countries. Broader diffusion of knowlegde and further work in this field would allow not only improved living conditions and lower mining cost, but may also permit the development of mines in desert areas. There is no system of mechanism by which information regarding newly available techniques can be brought quickly to the attention of the developing countries. However, when and wherever U.N. experts are requested by governments to look into this problem, such experts have drawn attention to such methods. It is hoped that, in the near future, the U.N. will be able to organize a seminar on dry mineral processing methods in developing countries.

The Growing Needs for Ore Processing and its Implication for Developing Countries

41. In general, only well located higher grade ores can be developed for export. Where very little exploration has so far been carried out, there is still hope of discovering new high grade ore deposits, which are well located, but the time is approaching when almost all easily found and rich deposits will have been developed. Of the present iron ore reserves in the world, it was esti ated, for the year 1960, that only one third was direct shipping ore. Therefore, two-thirds needed beneficiation before they could be shipped or locally consumed (1)

(1) Bruce C. NETSCHERT and Hans H. LANDSBERG "The Future Supply of the Major Metals", Resources for the Future, Washington D.C., 1961. Table 2, page 20.

With many minerals, the technology of concentration, progressively advancing over the years, has allowed the utilisation of ores with a steadily decreasing mineral content, in the case of copper, the average grade of ore mined in the United States has decreased from 3% in the 1880 to 0.8 for the average of the years 1951-1956 (2). Similar data are available for a number of other minerals.

42. The decrease in grade of an exploitable mineral means one thing for the developing countries; namely that the ore in its unprocessed state, cannot be shipped and therefore must be concentrated near the mine. Consequently, on a long term basis, developing countries have to foresee the increasing need for efficient treatment processes. This recognition in itself will lead to a number of consequences. The whole field of mineral processing technology is becoming increasingly important and this technology, sooner or later, will have to be acquired by all countries in which the mining industry plays a considerable role. In the developing countries, this will call for the establishment of additional laboratories and for an expanding university research programme to undertake applied research on a day-to-day basis for quickly and efficiently solving problems which plague the mining industry. It will also call for a whole series of economic studies on the relationship of investments, not only in the treatment facilities themselves, but also in related energy, water and similar facilities.

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(2) O.C. HERFINDAHL "Copper Costs and Prices : 1870-1957", Resources for the Future, Baltimore : John Hopkins Press, 1960, page 224.

CHAPTER IV

THE NEED FOR INTERNATIONAL CO-OPERATION

(a) Regional Co-operation:

43. It is difficult for small developing countries to set up and finance properly staffed geological and mining agencies, laboratories, training institutes, etc. It may be advisable therefore for smaller developing countries to set up joint facilities for map making and geological studies, central laboratories, central training facilities, etc. In Western Africa, such co-operation is now under discussion, and it is a policy of the Special Fund to give full support to regional institutes, provided the need and the full co-operation of the Governments concerned can be clearly demonstrated to the Special Fund. This field of regional co-operation is one in which essentially, the initiative will have to come from the Governments themselves. If such co-operation can be brought about, support from international organizations will usually be forthcoming.

(b) Multi-lateral Technical Assistance:

44. The United Nations is providing developing countries, under its Technical Assistance Programme, with experts in the whole field of mining. Under this programme, about 200 experts, essentially as advisers, are provided each year to developing countries. All relevant professions are involved, from exploration geologists to ore dressers. Such experts stay in the country and work with the Government department concerned for short or long-term periods, as desired by the Government. The United Nations also provides, under its OPEX Programme, a limited number of U.N. experts who become Government officials in executive functions. The funds available under the OPEX Programme allow the appointment of only a small number of experts each year.

45. Finally, the United Nations executes for the Special Fund a considerable number of projects concerned either with mineral surveys or with the establishment of geological and mineral institutes. In all such projects, the United Nations carries out the project under its own responsibility through a Project Manager who is a United Nations official and who is assisted by foreign as well as by locally appointed experts. The project is carried out with full co-operation of the Government. Most of the projects cost more than one million dollars and are financed by the Special Fund and by the Government concerned on a fifty-fifty basis. The United Nations also provides fellowships under its Technical Assistance programme as well as under Special Fund projects for further training of local personnel abroad.

(c) Bi-lateral Assistance:

46. Bi-lateral assistance in the field of mining is provided by most of the industrial countries and even by some of the developing countries to other developing countries. A full description of these programmes cannot be provided here.

(d) Other International Contacts:

47. There is a number of international professional organizations which hold regular conferences and issue journals which provide means for technical personnel in developing countries to maintain professional and personal contacts on an international basis. Governments in developing countries should provide facilities for its professional staff to maintain such contacts in every way possible.

ANNEX I

INVESTMENT REQUIREMENTS FOR SOME REPRESENTATIVE GROUPS OF MINERALS ACCORDING TO THE FOUR BASIC STAGES OF DEVELOPMENT

	Petroleum	Coal	Metallic minerals	Industrial minerals	Building materials	Precious metals		Diamonds	
						Alluvial	Underground	Alluvial	Underground
Exploration	high	medium	medium	medium	low	low	medium	low	medium
Extraction:									
Underground	high	high	high	high	-	-	high	-	high
Open cast	-	low	low	low	low	low	-	low	-
Processing	high	low	high	medium	low	-	low	-	low
Transportation 1/	medium	high	medium	medium	high	low	low	low	low

1/ Per unit of value.

1859 E - Dec.1962 - 1,600